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(54) **ROBOT**

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CPC **B23K 37/02** (2013.01); **B23K 37/0247** (2013.01); **B25J 18/02** (2013.01); **B25J 19/0008** (2013.01); **B25J 19/0025** (2013.01); **Y10S 901/42** (2013.01); **Y10T 74/20311** (2015.01); **Y10T 74/20317** (2015.01)

(58) **Field of Classification Search**

None

See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

3,587,872 A * 6/1971 Pauly 414/732

4,378,959 A * 4/1983 Susnjara 414/732

4,534,006 A * 8/1985 Minucciani et al. 700/249

4,767,257 A * 8/1988 Kato 414/744.5

5,006,035 A * 4/1991 Nakashima et al. 414/680

5,065,062 A * 11/1991 Uehara et al. 310/114

5,132,601 A * 7/1992 Ohtani 318/568.1

5,212,432 A * 5/1993 Ohtani et al. 318/568.11

5,437,207 A * 8/1995 Zimmer 74/490.02

5,564,312 A * 10/1996 Brunman et al. 74/490.02

5,606,235 A * 2/1997 Mauletti 318/625

6,250,174 B1 * 6/2001 Terada et al. 74/490.02

6,335,510 B1 * 1/2002 Carbines 219/125.1

6,408,710 B1 * 6/2002 Kullborg et al. 74/490.03

7,979,160 B2 * 7/2011 Teaford et al. 700/254

8,051,796 B2 * 11/2011 Clifford 118/323

(Continued)

FOREIGN PATENT DOCUMENTS

EP 2450158 A1 * 5/2012

JP 2011-200989 10/2011

OTHER PUBLICATIONS

Chinese Office Action for corresponding CN Application No. 201410366578.9, Aug. 25, 2015.

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(57) **ABSTRACT**

A robot includes: a stage unit; a rotation base connected to the stage unit in a rotatable manner around a predetermined rotating axis; an arm unit connected to the rotation base and having a base end rotatable around a first rotation axis that is substantially orthogonal to the rotating axis; a balancer connected to both the rotation base and the arm unit; and a cable arranged along the arm unit outside the balancer while supported by that balancer.

10 Claims, 7 Drawing Sheets

(56)

References Cited

U.S. PATENT DOCUMENTS

8,288,687	B2 *	10/2012	Inoue et al.	219/136	2013/0218324	A1 *	8/2013	Furuya	700/192
2004/0261562	A1 *	12/2004	Haniya et al.	74/490.02	2014/0013893	A1 *	1/2014	Asano et al.	74/490.02
2005/0193854	A1 *	9/2005	Sanemasa	74/490.02	2014/0020498	A1 *	1/2014	Adachi	74/490.02
2005/0204850	A1 *	9/2005	Nihei et al.	74/490.01	2014/0030032	A1 *	1/2014	Kuhn	406/196
2007/0169231	A1 *	7/2007	Zhang et al.	901/31	2014/0083229	A1 *	3/2014	Kume	74/490.02
2009/0224109	A1 *	9/2009	Hasunuma et al.	248/52	2014/0102240	A1 *	4/2014	Inada et al.	74/490.02
2009/0249915	A1 *	10/2009	Iwai et al.	74/490.02	2014/0137685	A1 *	5/2014	Iwayama	74/490.02
2010/0043587	A1 *	2/2010	Broberg et al.	74/490.01	2014/0196563	A1 *	7/2014	Takahashi et al.	74/490.06
2010/0162845	A1 *	7/2010	Yonehara et al.	74/490.01	2014/0290415	A1 *	10/2014	Hasuo	74/490.02
2011/0072930	A1 *	3/2011	Bayer et al.	74/490.01	2015/0007681	A1 *	1/2015	Murakami	74/490.02
2012/0186381	A1 *	7/2012	Robinson et al.	74/490.02	2015/0027261	A1 *	1/2015	Okahisa et al.	74/490.02
2013/0055842	A1 *	3/2013	Okada	74/490.03	2015/0039125	A1 *	2/2015	Takahashi et al.	700/245
					2015/0068349	A1 *	3/2015	Hirabayashi	74/490.03
					2015/0068350	A1 *	3/2015	Kirihara et al.	74/490.05

* cited by examiner

FIG. 1

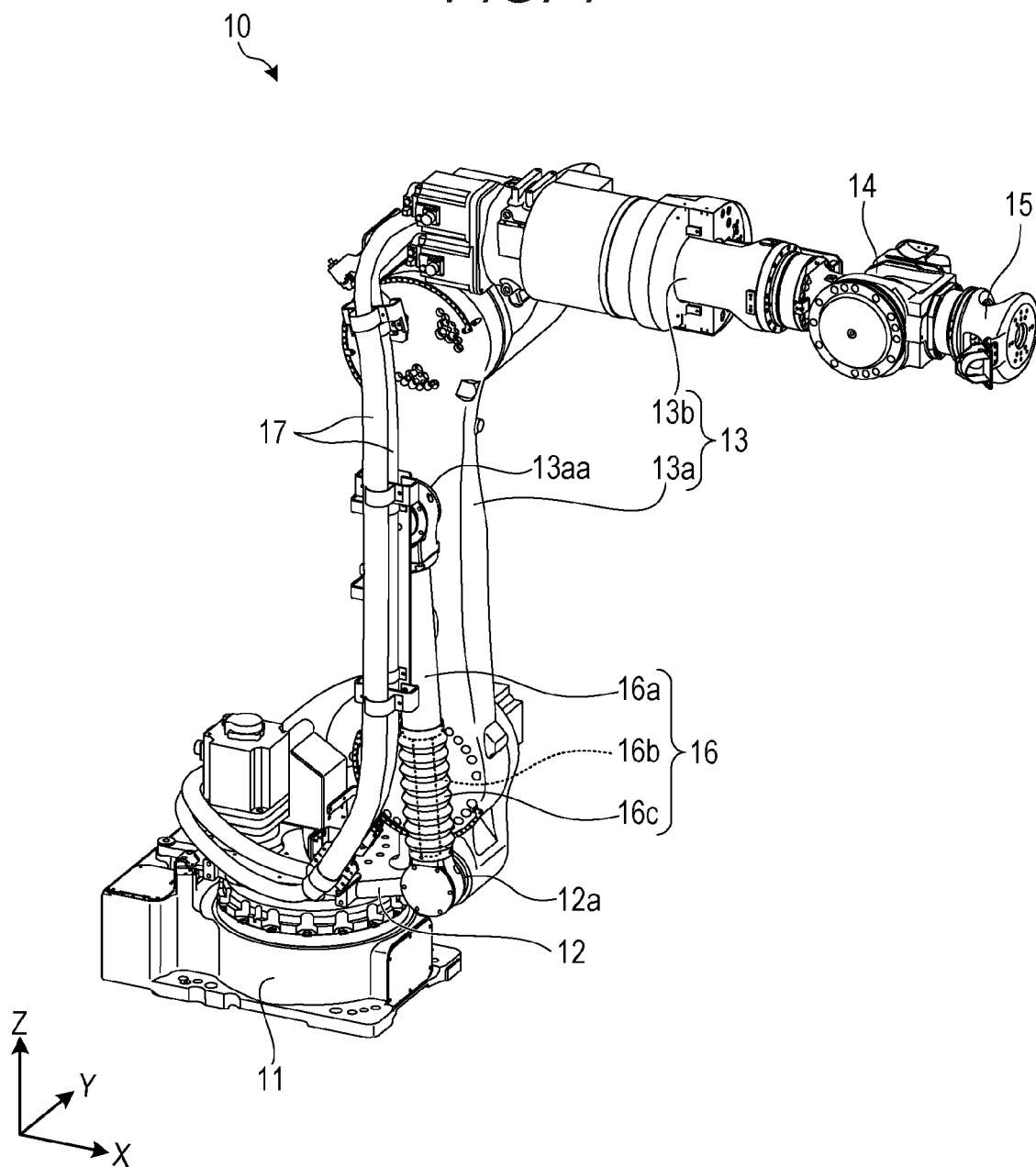


FIG. 2A

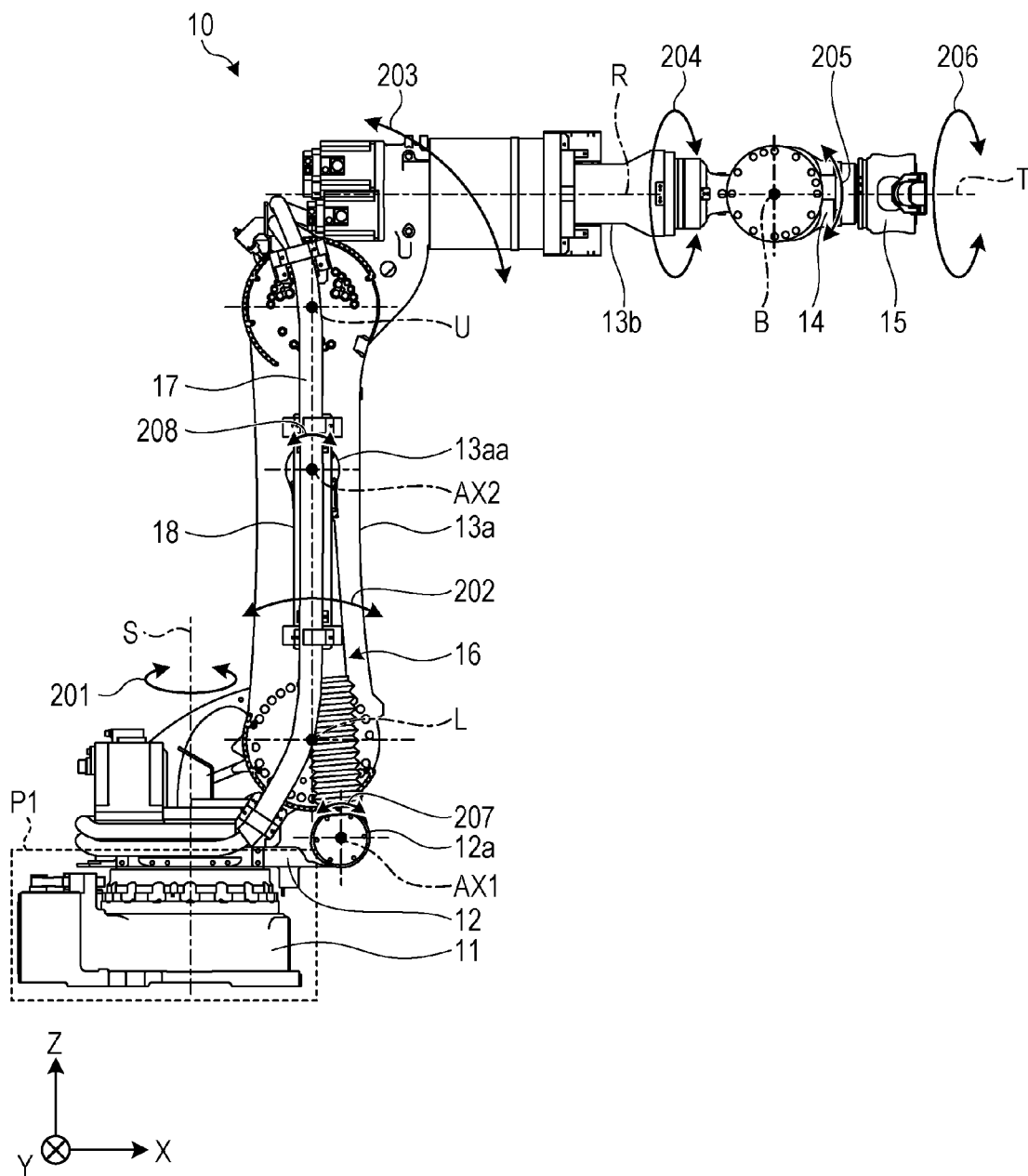


FIG. 2B

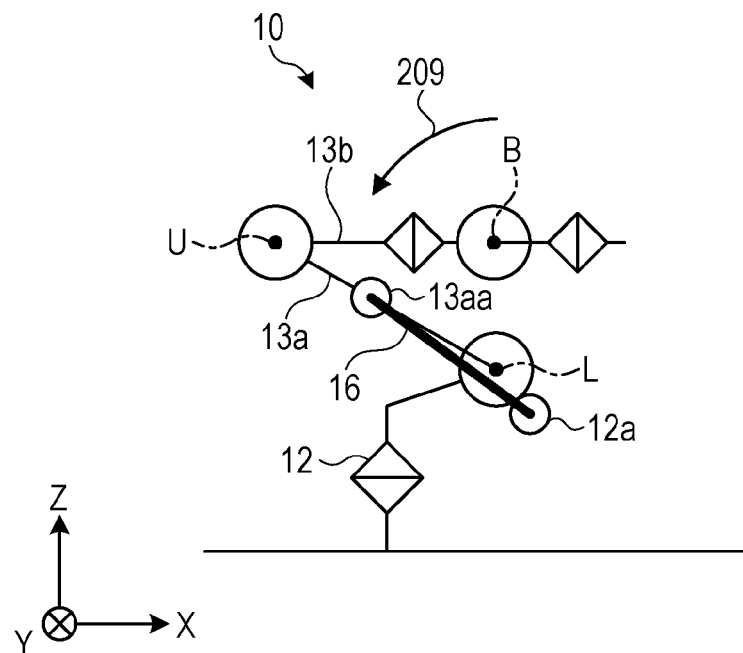
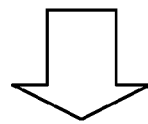
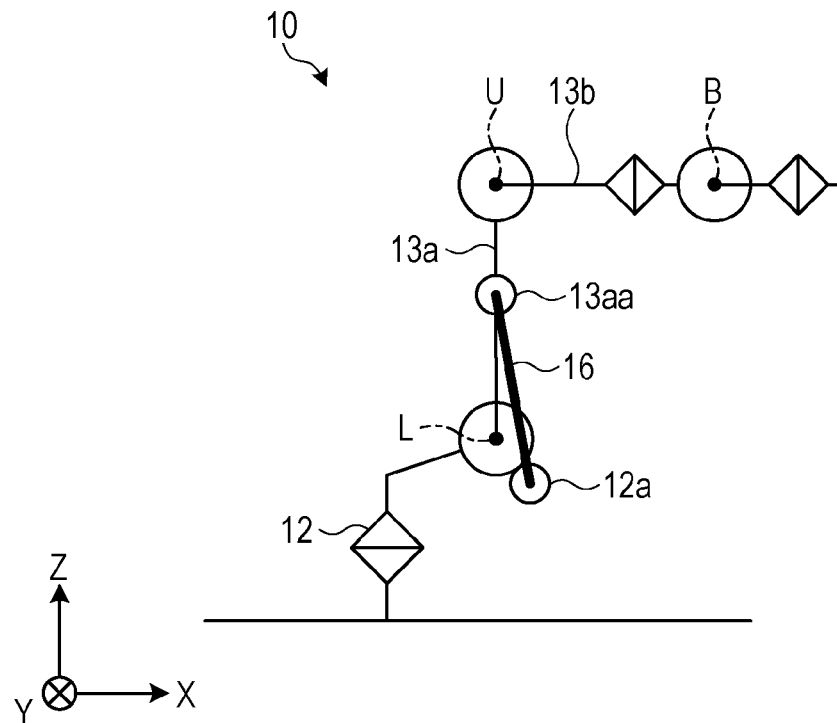


FIG. 3A

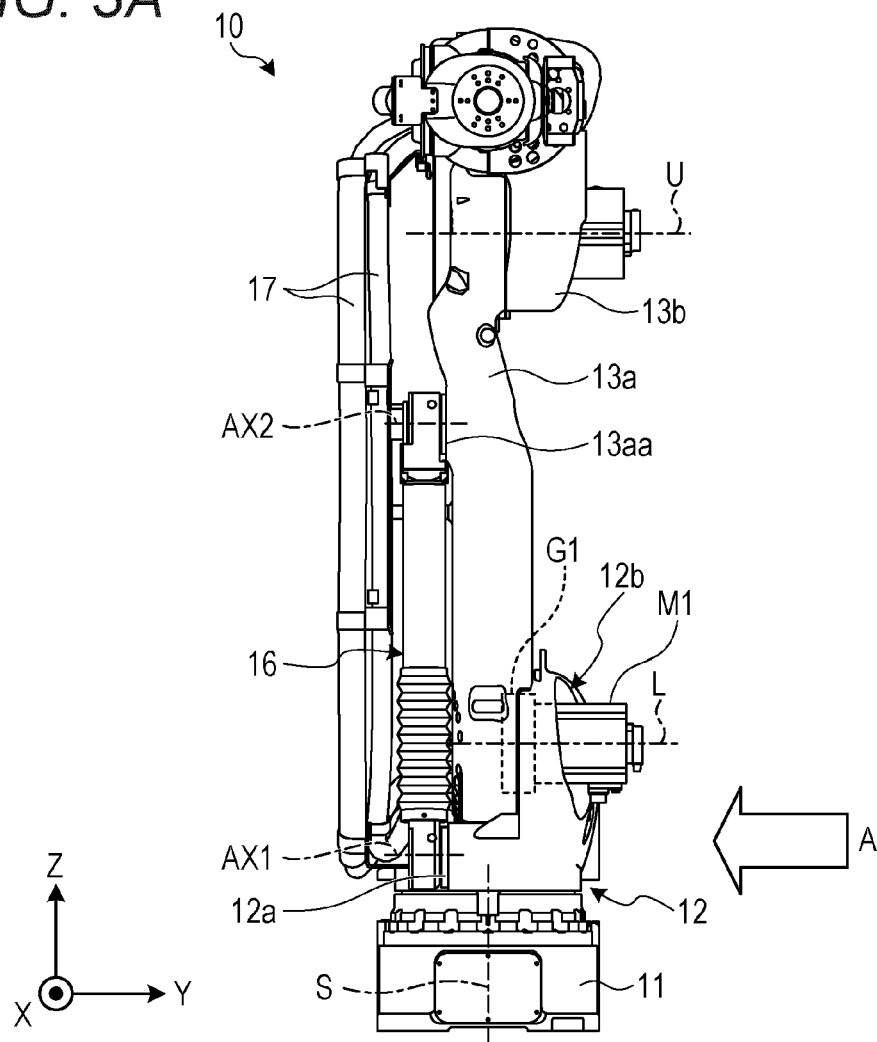


FIG. 3B

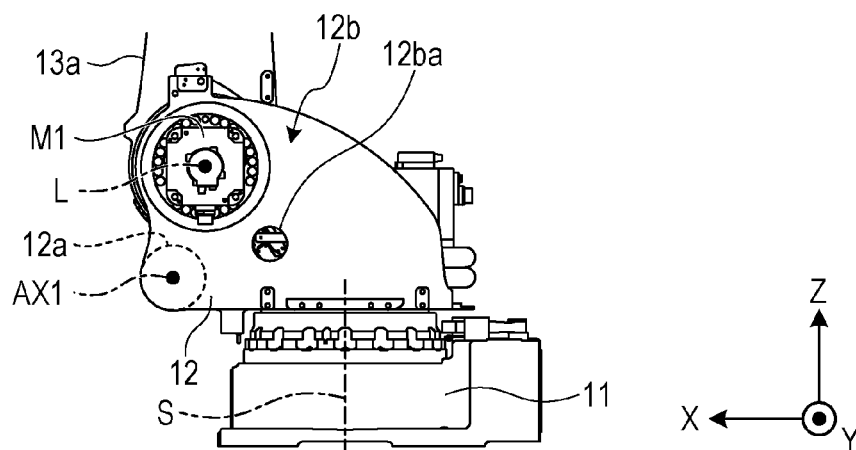


FIG. 4A

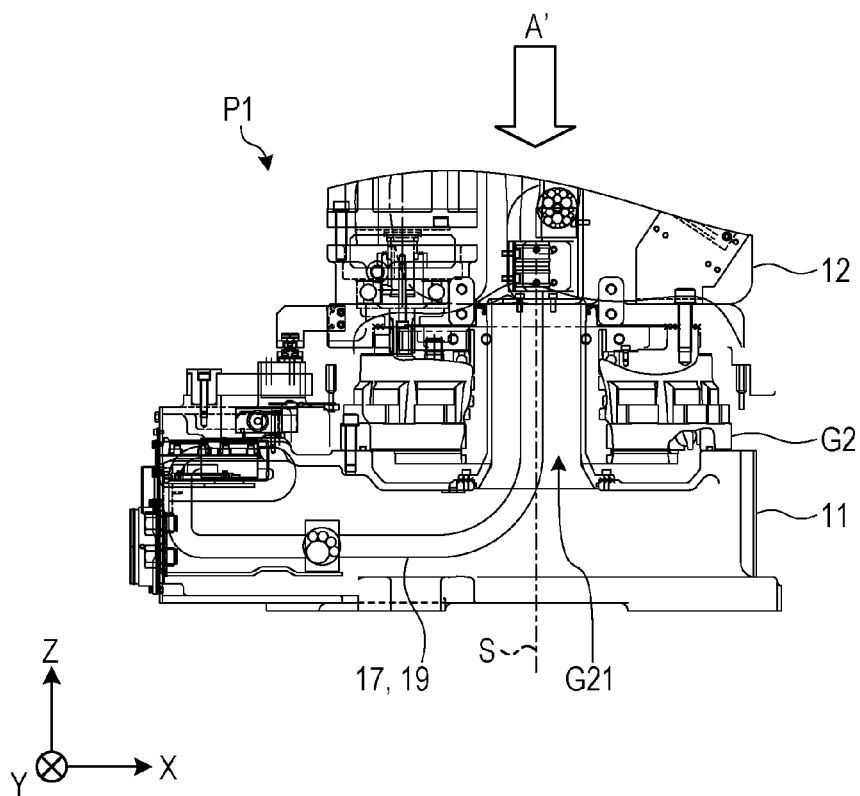


FIG. 4B

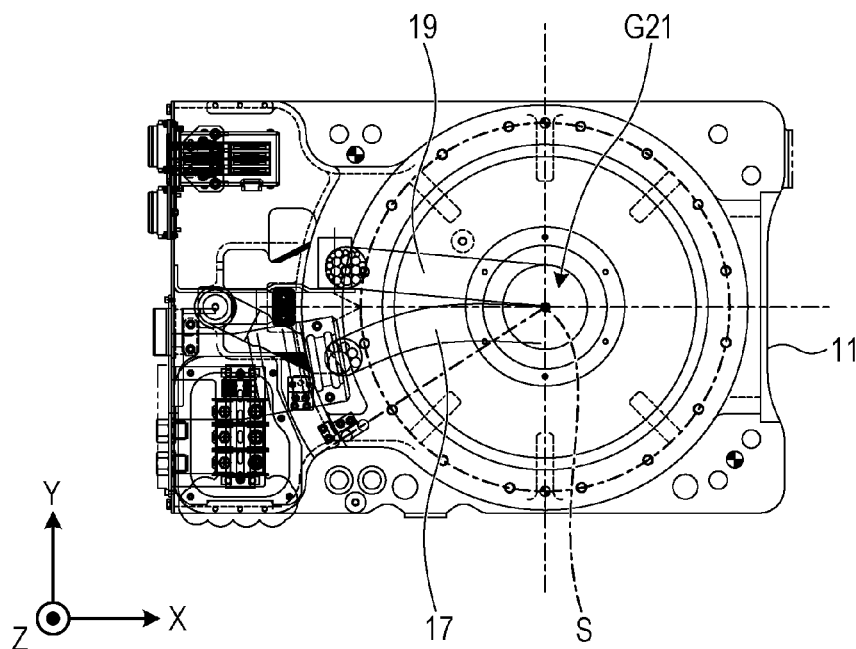


FIG. 4C

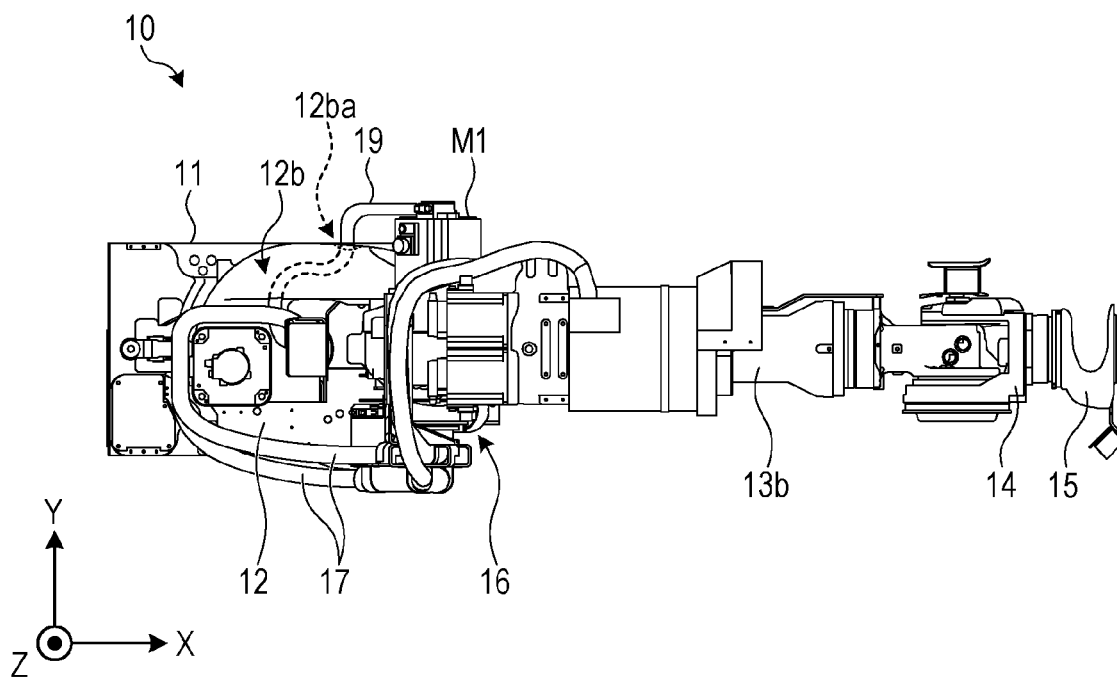


FIG. 5A

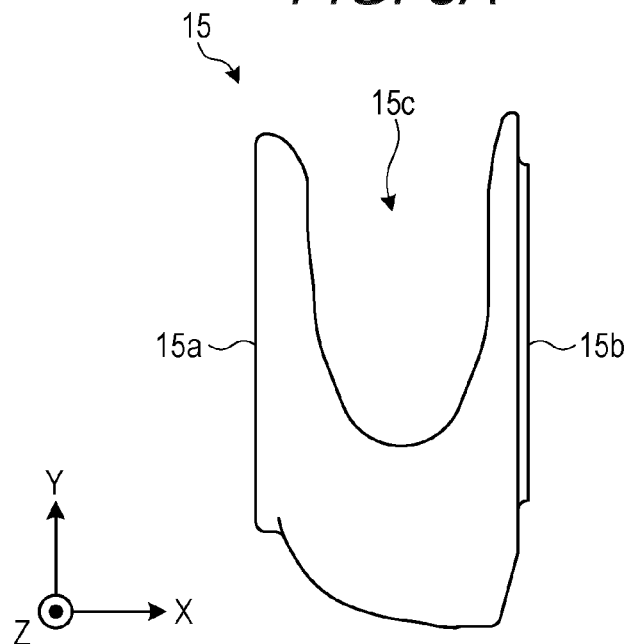
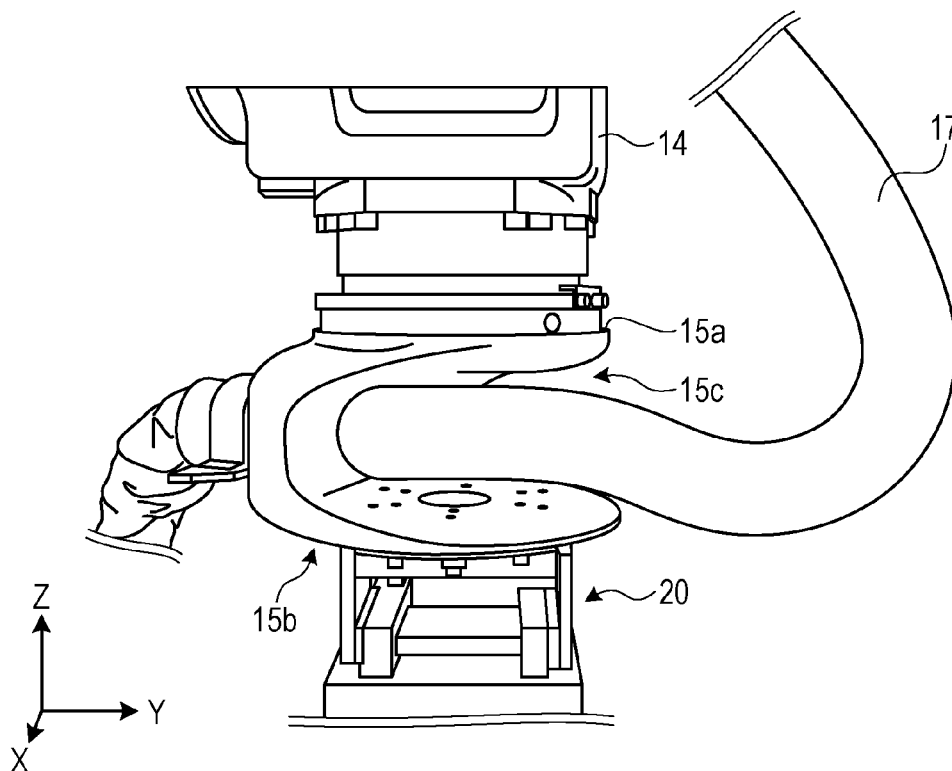


FIG. 5B



1 ROBOT

CROSS-REFERENCE TO RELATED APPLICATION

This application claims priority from Japanese Patent Application No. 2013-158210 filed with the Japan Patent Office on Jul. 30, 2013, the entire content of which is hereby incorporated by reference.

BACKGROUND

1. Technical Field

The disclosed embodiments relate to a robot.

2. Related Art

JP-A-2011-200989 discloses robots have a rotation base and a multi-axis arm. The rotation base is provided in a rotatable manner with respect to a stage unit fixed on a floor. The multi-axis arm is attached to the rotation stage.

Further, a balancer for weight compensation is connected to the rotation base. For the balancer, the spring type one is often used.

Further, a cable rigged to the robot is arranged twisted around the outside of the rotation base. Furthermore, the cable is arranged along the multi-axis arm from the outer circumference of the rotation base.

SUMMARY

A robot includes: a stage unit; a rotation base connected to the stage unit in a rotatable manner around a predetermined rotating axis; an arm unit connected to the rotation base and having a base end rotatable around a first rotation axis that is substantially orthogonal to the rotating axis; a balancer connected to both the rotation base and the arm unit; and a cable arranged along the arm unit outside the balancer while supported by that balancer.

BRIEF DESCRIPTION OF DRAWINGS

FIG. 1 is a perspective view of a robot according to an embodiment;

FIG. 2A is a left side view of a configuration of the robot according to the embodiment;

FIG. 2B is a schematic diagram of an advantages allowed by a balancer according to the embodiment;

FIG. 3A is a front view of the robot according to the embodiment;

FIG. 3B is a view around a rotation base viewed from an arrow A indicated in FIG. 3A;

FIG. 4A is a transparent view around a P1 part indicated in FIG. 2A;

FIG. 4B is a transparent view of the P1 part viewed from an arrow A' indicated in FIG. 4A;

FIG. 4C is a plane view of the robot according to the embodiment;

FIG. 5A is a plane view of a flange unit; and

FIG. 5B is a schematic diagram of a use state of the flange unit.

DETAILED DESCRIPTION

In the following detailed description, for purpose of explanation, numerous specific details are set forth in order to provide a thorough understanding of the disclosed embodiments. It will be apparent, however, that one or more embodiments may be practiced without these specific details. In other

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instances, well-known structures and devices are schematically shown in order to simplify the drawing.

A robot according to one form of an embodiment has a stage unit, a rotation base, an arm unit, a balancer, and a cable.

The rotation base is connected to the stage unit in a rotatable manner around a predetermined rotating axis. The arm unit is connected to the rotation base so that the base end of the arm unit is rotatable around a rotation axis that is substantially orthogonal to the rotating axis. The balancer is connected to both the rotation base and the arm unit. The cable is arranged along the arm unit outside the balancer while supported by that balancer.

One form of the embodiments allows for space saving.

By referring to the attached drawings, described in detail below will be the embodiments of a robot disclosed by the present application. It is noted that the scope of the disclosure is not limited by the following embodiments.

In the followings, the description will be provided by exemplifying a robot used for spot welding.

Firstly, the general configuration of a robot 10 according to the embodiment will be described. FIG. 1 is a perspective view of the robot 10 according to the embodiment. It is noted that, in the followings, a positional relationship among respective units of the robot 10 will be described assuming that the rotation position and attitude of the robot 10 is basically in a state as depicted in FIG. 1 for the purpose of description.

Further, for the better understanding of the description, FIG. 1 depicts a three-dimensional orthogonal coordinate system including the Z axis whose positive direction is the perpendicularly upper direction. Such orthogonal coordinate system may also be applied to other drawings used for the following description. It is noted that, in the present embodiment, the positive direction of the X axis indicates the front direction of the robot 10.

As illustrated in FIG. 1, the robot 10 is of so-called vertical multi joint type. Specifically, the robot 10 has a stage unit 11, a rotation base 12, an arm unit 13, a wrist unit 14, and a flange unit 15. The wrist unit 14 is an example of a swing unit.

Further, the arm unit 13 has a lower arm 13a and an upper arm 13b. The lower arm 13a is an example of a first arm. Also, the upper arm 13b is an example of a second arm.

The stage unit 11 is a support base fixed on a floor. The rotation base 12 is provided to the stage unit 11 in a rotatable manner. The lower arm 13a is provided to the rotation base 12 in a rotatable manner.

The upper arm 13b is provided to the lower arm 13a in a rotatable manner. The wrist unit 14 is provided to the tip end of the upper arm 13b in a swingable manner. Further, the flange unit 15 is provided to the wrist unit 14 in a rotatable manner. In addition, an end effector such as a spot welding gun can be attached to the flange unit 15.

Further, the robot 10 has a balancer 16 for weight compensation. The balancer 16 has a cylinder unit 16a that is filled with fluid such as nitrogen gas, and a rod unit 16b that is expanded and contracted by a pressure of the fluid. It is noted that other gas or liquid such as oil may be used for the fluid in the cylinder unit 16a.

The balancer 16 is connected to the rotation base 12 and the lower arm 13 a via a first attachment unit 12a provided to the rotation base 12 and a second attachment unit 13aa provided to the lower arm 13a, respectively.

It is noted that, at the rod unit 16b of the balancer 16, a rod having a smaller radius than the cylinder unit 16a is covered with a bellows-like cover member 16c. The cover member 16c is expanded and contracted according to the expansion and contraction of the rod. As such, it is effective to cover the

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rod with the cover member **16c**, because the burning by a heated piece such as a spatter is suppressed when the robot **10** is used for the welding. It is noted that the shape of the cover member **16c** is not always required to be bellows-shaped but may be any shape that covers the rod unit **16b** in a cylindrical manner.

Further, the robot **10** has a cable **17**. The cable **17** is some of cables and/or hoses and the like equipped for the welding. The cable **17** is routed along the lower arm **13a** outside the balancer **16** while supported by the above-described balancer **16**.

Further, the cable **17** is routed with respect to the upper arm **13b** so as to round the outside of the base end of the upper arm **13b** and be directed to the tip end of the upper arm **13b**.

The robot **10** of the present embodiment is to achieve the space saving in the above-described configuration. The robot **10** then enables the rotation base **12**, the arm unit **13**, and the wrist unit **14** to operate without being affected by undesirable restriction by the cable **17**. The robot **10** performs handling operation such as spot welding operation by controlling the position and attitude of the end effector attached to the wrist unit **14**.

The configuration of the robot **10** will be described below in further detail by using FIG. 2A and subsequent drawings. FIG. 2A is a left side view of the configuration of the robot **10** according to the embodiment.

As illustrated in FIG. 2A, the rotation base **12** is connected to the stage unit **11** in a rotatable manner around the rotating axis S (see the arrow **201** in the figure). It is noted that, in the coupling portion of the stage unit **11** and the rotation base **12**, the cable **17** is routed so as to achieve the space saving. The details of this point will be described later by using the transparent views (FIG. 4A and FIG. 4B) of a P1 part depicted in the figures.

Further, as illustrated in FIG. 2A, the lower arm **13a** is connected to the rotation base **12** so that the base end of the lower arm **13a** is rotatable around an axis L that is substantially orthogonal to the rotating axis S (see the arrow **202** in the figure). The axis L is an example of a first rotation axis.

Further, the upper arm **13b** is connected to the tip end of the lower arm **13a** so that the base end of the upper arm **13b** is rotatable around an axis U that is substantially parallel to the axis L (see the arrow **203** in the figure). It is noted that the upper arm **13b** operates so as to extend more forward than the lower arm **13a** at the rotation position of the origin (see the rotation center of the axis U).

In addition, the upper arm **13b** is provided so as to be able to twist around an axis R that is substantially orthogonal to the axis U (see the arrow **204** in the figure).

Further, the wrist unit **14** is connected to the tip end of the upper arm **13b** swingable (or rotatable) around an axis B that is substantially orthogonal to the axis R (see the arrow **205** in the figure). Further, the flange unit **15** is connected to the wrist unit **14** in a rotatable manner around an axis T that is substantially orthogonal to the axis B (see the arrow **206** in the figure). It is noted that the axis B is a rotation axis that is substantially parallel to the axis L. The axis B is an example of a second rotation axis. The axis T is an example of a third rotation axis.

In addition, the flange unit **15** is provided with an end effector attachment unit **15b** (described later) enabling the attachment of the end effector. The details of the flange unit **15** will be described later by using FIG. 5A and FIG. 5B.

Further, in the balancer **16** as illustrated in FIG. 2A, the base end of the balancer **16** is attached to the first attachment unit **12a**, while the tip end of the balancer **16** is attached to the

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second attachment unit **13aa**. That is, the balancer **16** is connected to both the rotation base **12** and the lower arm **13a**.

Further, the balancer **16** is attached to the first attachment unit **12a** in a rotatable manner around an axis AX1 that is substantially parallel to the axis L (see the arrow **207** in the figure). Further, the balancer **16** is attached to the second attachment unit **13aa** in a rotatable manner around an axis AX2 that is substantially parallel to the axis L (see the arrow **208** in the figure). It is noted that the axis AX1 is an example of a first support axis and the axis AX2 is an example of a second support axis.

Here, as illustrated in FIG. 2A, the first attachment unit **12a** is arranged in the outside, in the rotation radius direction, of the main part of the rotation base **12** and nearer to the stage unit **11** than the axis L. That is, the first attachment unit **12a** is formed so that the base end of the balancer **16** is able to be attached in more front of the robot **10** than the rotation base **12**.

Described will be the advantages allowed by the balancer **16** attached in this way. FIG. 2B is a schematic diagram of the advantages allowed by the balancer **16** according to the embodiment. It is noted that, in FIG. 2B, the upper figure illustrates the robot **10** in a state where the lower arm **13a** is elected and the lower figure illustrates the robot **10** in a state where the lower arm **13a** is collapsed rearward. In these figures, the robot **10** is depicted in a quite schematic manner using graphic symbols that indicate the joints.

As illustrated in FIG. 2B, the base end of the balancer **16** is arranged via the first attachment unit **12a** in more front of the robot **10** than the rotation base **12**. This allows the lower arm **13a** to be collapsed rearward in a wider range (see the arrow **209** in the figure). This is because the force supporting upward the lower arm **13a** that is being collapsed rearward is applied by the balancer **16**.

This allows for improved flexibility in the attitude that the robot **10** is able to take in the spot welding operation. Further, it allows the robot **10** to take a more compact attitude in the conveyance of the robot **10**, that is, which allows the robot **10** to be collapsed in a more compact manner. Therefore, the volume at the conveyance can be reduced.

Further, the attachment of the balancer **16** in the above manner is unlikely to cause the increased footprint, compared to the case where the conventional spring type balancer is attached. That is, the footprint is narrowed, so that the space saving can be achieved.

Turning back to the description of FIG. 2A, the cable **17** is routed to the upper part of the rotation base **12** from the coupling portion of the stage unit **11** and the rotation base **12** as illustrated in FIG. 2A. Furthermore, the cable **17** is routed along the lower arm **13a** outside the balancer **16** while supported by the balancer **16**.

That is, the cable **17** is routed while supported by the balancer **16** that reduces the footprint as described above. Therefore, again, the space saving can be achieved.

It is noted that the robot **10** further has a stay **18**. The stay **18** is provided along the balancer **16**. The stay **18** is fixed at two points to the cylinder unit **16a** by a support member. The cable **17** is supported by the balancer **16** by being fixed to the tip end of the balancer **16** via the stay **18**. The stay **18** is an example of a support member.

Further, the cable **17** is routed with respect to the upper arm **13b** so as to round the outside of the base end of the upper arm **13b** and be directed to the tip end of the upper arm **13b**. Thereby, the cable **17** is unlikely to be caught between the upper arm **13b** and the lower arm **13a**. This allows the robot **10** to operate without being undesirably restricted by the cable **17**.

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This feature is useful in the spot welding in which the cable 17 tends to be bulky with cables and/or hoses equipped for the welding.

Next, the configuration around the rotation base 12 will be described in further details. FIG. 3A is a front view of the robot 10 according to the embodiment. Further, FIG. 3B is a view around the rotation base 12 viewed from the arrow A illustrated in FIG. 3A.

As illustrated in FIG. 3A, the robot 10 further has a servo motor M1 and a reduction gear G1. The servo motor M1 applies, to the lower arm 13a, a rotary driving force for rotating the lower arm 13a around the axis L. The reduction gear G1 is connected to the servo motor M1 so as to be able to transfer the motive power.

The rotation base 12 has a connection unit 12b. The connection unit 12b accommodates the reduction gear G1 so that it is connected to the lower arm 13a in a rotatable manner. Thus, the connection unit 12b also supports the servo motor M1 connected to the reduction gear G1.

It is noted that the rotation base 12 is a cast metal. The connection unit 12b is integrally formed with the rotation base 12.

Further, under the lower arm 13a, the above-described first attachment unit 12a extends from the lower part of the connection unit 12b in substantially parallel to the axis L. The first attachment unit 12a is connected to the base end of the balancer 16 in more extending direction side (in the Y axis negative side in the figure) than the lower arm 13a. The first attachment unit 12a is also integrally formed with the rotation base 12.

Further, as illustrated in FIG. 3B, the connection unit 12b is provided with a hole 12ba. Into the hole 12ba, a cable 19 (described later) connected to the servo motor M1 is inserted.

Next, the routing of the cables including the cable 19 and the above-described cable 17 will be described by using FIG. 4A to FIG. 4C. FIG. 4A is a transparent view around the P1 part indicated in FIG. 2A, FIG. 4B is a transparent view of the P1 part viewed from the arrow A' indicated in FIG. 4A, and FIG. 4C is a plane view of the robot 10 according to the embodiment.

As illustrated in FIG. 4A, the stage unit 11 and the rotation base 12 are connected via a hollow reduction gear G2 having a hollow hole G21 along the rotating axis S. The hollow reduction gear G2 is an example of a rotation member.

Here, the cable 17 and the cable 19 are first routed from the outside of the robot 10 to the hollow hole G21. Here, these cables are routed without being arranged around the rotating axis S (without being subjected to the U-shape motion bent process and the like) inside the stage unit 11.

As illustrated in FIG. 4B, the cable 17 and the cable 19 are then subjected to the twist process in the hollow hole G21. Therefore, according to the robot 10 of the present embodiment, it can be suppressed that the stage unit 11 would otherwise become undesirably large due to the cables arranged therearound.

Therefore, the footprint of the robot 10 can be narrowed and the cables can be arranged in a high density. That is, the space saving can be achieved.

It is noted that the cables twisted inside the hollow hole G21 is routed through the hollow hole G21 and from the stage unit 11 to the upper part of the rotation base 12, as illustrated in FIG. 4C. Furthermore, the cables are branched at the upper part of the rotation base 12.

One of the branched cables 19 is connected to the servo motor M1 through the hole 12ba of the connection unit 12b. Further, the other branched cable 17 is gathered with another

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cable 17. These cables 17 are routed around the peripheral of the servo motor M1 and along the stay 18.

Next, the details of the flange unit 15 will be described by using FIG. 5A and FIG. 5B. FIG. 5A is a plane view of the flange unit 15, and FIG. 5B is a schematic diagram of a use state of the flange unit 15.

As illustrated in FIG. 5A, the flange unit 15 is formed in substantially a U-shape in a plane view. The flange unit 15 has a part to be attached 15a, an end effector attachment unit 15b, and an opening 15c.

It is noted that the bottom of the flange unit 15 opposing to the opening 15c is also opened though its depiction is omitted in FIG. 5A.

The flange unit 15 is attached to the wrist unit 14 by the part to be attached 15a, as illustrated in FIG. 5B. Further, to the end effector attachment unit 15b, a spot welding gun 20 is attached, for example, as an end effector. Thereby, the wrist unit 14 and the spot welding gun 20 are jointed via the flange unit 15.

Further, as described above, the cable 17 is routed along the upper arm 13b from the lower arm 13a. The cable 17 is inserted into the bottom side of the flange unit 15 from the U-shaped opening 15c side of the flange unit 15 and then connected to the spot welding gun 20.

Then, the cable 17 is held by the flange unit 15 with spatial room. This allows the cable 17 to move in a high flexibility in the space within the flange unit 15 even when the spot welding gun 20 is rotated in response to the rotation of the wrist unit 14.

That is, even when the cables 17 are the cables equipped for the welding that are likely to be bulky, the cables 17 can be gathered in a compact manner, and the high flexibility in the operation of the cables 17 can be maintained. This allows the robot 10 to perform the spot welding operation without being affected by the undesirable restriction (such as the interference) in the operation.

As has been described above, the robot according to the present embodiment has the stage unit, the rotation base, the arm unit, the balancer, and the cable. The rotation base is connected to the stage unit in a rotatable manner around a predetermined rotating axis. The arm unit is connected to the rotation base so that the base end of the arm unit is rotatable around the first rotation axis that is substantially orthogonal to the rotating axis.

The balancer is connected to both the rotation base and the arm unit. The cable is arranged along the arm unit outside the balancer while supported by the balancer.

Therefore, the robot of the embodiment allows for the space saving.

It is noted that, in the embodiment described above, the example in which the robot is used for the spot welding has been described. However, the type of the operation performed by the robot is not limited to the spot welding. That is, for example, a hand that is able to hold a work may be attached as the end effector in place of the spot welding gun. In this case, the robot can be used for the handling operation of the work.

Further, in the embodiment described above, the example in which the balancer is held at its base end and tip end has been described. However, the supported portion of the balancer is not limited to them. That is, the balancer may be supported its one part and another part, or at least two points.

Further, in the embodiment described above, the multi-axis robot having six axes has been exemplified. However, the number of axes of the robot is not limited to it. The robot may be the multi-axis robot having seven axes, for example.

Further, in the embodiment described above, the robot with a single arm has been exemplified. Without limited to it,

however, the above-described embodiment may be applied to at least any one of the arms of the multi-arm robot having two or more arms.

Further advantages and/or modifications can be readily derived by those skilled in the art. Thus, broader forms of the technique of the present disclosure are not limited to the specific details and the exemplary embodiments that have been illustrated and described above. Therefore, various modifications are possible without departing from the spirit and scope of the encompassing concept of the technique of the present disclosure defined by the appended claims and their equivalents.

Further, the robot according to one embodiment of the present disclosure may be the following first to eleventh robots. The first robot has a stage unit; a rotation base connected to the stage unit in a rotatable manner around a predetermined rotating axis; an arm unit having a base end connected to the rotation base in a rotatable manner around a rotation axis that is substantially orthogonal to the rotating axis; a balancer connected to both the rotation base and the arm unit; and a cable arranged along the arm unit outside the balancer while supported by the balancer.

In the second robot according to the first robot, the arm unit has a first arm having a base end connected to the rotation base and a second arm having a base end connected to the tip end of the first arm in a rotatable manner around a parallel axis that is substantially parallel to the rotation axis, and the cable is routed with respect to the second arm so as to round the outside of a base end of the second arm and be directed to a tip end of the second arm.

The third robot according to the first or second robot further has a support member, and the cable is supported by the balancer by being fixed to a tip end of the balancer via the support member.

In the fourth robot according to any one of the first to third robots, the rotation base is formed with a connection unit for accommodating a reduction gear to be connected to the arm unit in a rotatable manner, a servo motor adapted to apply a rotary driving force of the arm unit is supported at the connection unit and connected to the reduction gear accommodated in the connection unit so as to be able to transfer motive power to the reduction gear.

In the fifth robot according to the fourth robot, a hole into which a cable connected to the servo motor is inserted is provided to the connection unit.

In the sixth robot according to the fifth robot, the stage unit and the rotation base are connected via a rotation member having a hollow hole along the rotating axis, the cable is routed through the hollow hole and from the stage unit to the upper part of the rotation base and branched at the upper part of the rotation base, one of the branched cables is connected to the servo motor through the hole of the connection unit, and the other cable is gathered with the cable and routed along the balancer.

The seventh robot according to any one of the first to sixth robots further has a first attachment unit provided to the rotation base and arranged in an outside, in a rotation radius direction, of the rotation base and nearer to the stage unit than the rotation axis; and a second attachment unit provided to the arm unit, a base end of the balancer is attached to the first attachment unit in a rotatable manner around a first support axis that is substantially parallel to the rotation axis, and a tip end of the balancer is attached to the second attachment unit in a rotatable manner around a second support axis that is substantially parallel to the rotation axis.

In the eighth robot according to any one of the first to seventh robots, the balancer has a cylinder unit filled with fluid and a rod unit expanded and contracted by a pressure of the fluid.

In the ninth robot according to any one of the first to eighth robots, the balancer has a cover member that covers the balancer.

The tenth robot according to any one of the second to ninth robots further has a swing unit connected to the second arm in a rotatable manner around a rotation axis that is substantially parallel to the rotation axis, a flange unit rotatable around a rotation axis that is substantially orthogonal to the rotation axis of the swing unit, and an end effector attachment unit provided to the flange unit and enabling attachment of an end effector.

In the eleventh robot according to the tenth robot, the end effector is a spot welding gun.

The foregoing detailed description has been presented for the purposes of illustration and description. Many modifications and variations are possible in light of the above teaching. It is not intended to be exhaustive or to limit the subject matter described herein to the precise form disclosed. Although the subject matter has been described in language specific to structural features and/or methodological acts, it is to be understood that the subject matter defined in the appended claims is not necessarily limited to the specific features or acts described above. Rather, the specific features and acts described above are disclosed as example forms of implementing the claims appended hereto.

What is claimed is:

1. A robot comprising:

a stage;

a rotation base connected to the stage in a rotatable manner around a predetermined rotating axis;

an arm connected to the rotation base and having a base end rotatable around a first rotation axis that is substantially orthogonal to the rotating axis, the arm comprising a first arm having a base end connected to the rotation base, and

a second arm having a base end connected to a tip end of the first arm in a rotatable manner around a parallel axis that is substantially parallel to the first rotation axis, and;

a balancer connected to both the rotation base and the arm; and

a first cable arranged along the arm outside the balancer while supported by that balancer, the first cable being routed with respect to the second arm so as to round outside of the base end of the second arm and being directed to a tip end of the second arm.

2. The robot according to claim 1 further comprising a supporter,

wherein the first cable is supported by the balancer by being fixed to a tip end of the balancer via the supporter.

3. The robot according to claim 1,

wherein the rotation base has a connection unit that accommodates a reduction gear so that the reduction gear is connected to the arm in a rotatable manner,

wherein the connection unit supports a servo motor adapted to apply a rotary driving force to the arm, and wherein the servo motor is connected to the reduction gear accommodated in the connection unit so as to be able to transfer motive power to the reduction gear.

4. The robot according to claim 3, wherein a hole into which a second cable to be connected to the servo motor is inserted is provided to the connection unit.

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5. The robot according to claim 4,
 wherein the stage and the rotation base are connected via a
 rotation member having a hollow hole along the rotating
 axis,
 wherein the second cable are routed through the hollow
 hole and from the stage to an upper part of the rotation
 base and branched at the upper part of the rotation base,
 wherein a one cable of a branched second cable is con-
 nected to the servo motor through the hole of the con-
 nection unit, and
 wherein the first cable is gathered with another cable of a
 branched second cable and routed along the balancer.
 6. The robot according to claim 1 further comprising:
 a first attachment provided to the rotation base, arranged in
 an outside, in a rotation radius direction, of the rotation
 base and nearer to the stage than the first rotation axis;
 and
 a second attachment provided to the arm, and
 wherein a base end of the balancer is attached to the first
 attachment in a rotatable manner around a first support
 axis that is substantially parallel to the first rotation axis,
 and

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wherein a tip end of the balancer is attached to the second
 attachment in a rotatable manner around a second sup-
 port axis that is substantially parallel to the first rotation
 axis.

7. The robot according to claim 1, wherein the balancer has
 a cylinder unit filled with fluid and a rod unit expanded and
 contracted by a pressure of the fluid.

8. The robot according to claim 1, wherein the balancer has
 a cover member that covers the balancer.

9. The robot according to claim 1 further comprising:
 a swinging device connected to the second arm in a rotat-
 able manner around a second rotation axis that is sub-
 stantially parallel to the first rotation axis;

a flange rotatable around a third rotation axis that is sub-
 stantially orthogonal to the second rotation axis; and
 an end effector attachment provided to the flange and
 enabling attachment of an end effector.

10. The robot according to claim 9, wherein the end effec-
 tor is a spot welding gun.

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